PATENT SPECIFICATION (11) 1 528 906

1 528 906

(21) Application No. 44089/74 (22) Filed 11 Oct. 1974 (19)

(23) Complete Specification filed 9 Oct. 1975

(44) Complete Specification published 18 Oct. 1978

(51) INT. CL.² A61F 1/24

(52) Index at acceptance
A5R X6

(72) Inventor ROGER DEE

(54) ENDOPROSTHETIC DEVICES

(71) We, NATIONAL RESEARCH DEVELOPMENT CORPORATION, a British Corporation established by Statute, of Kingsgate House, 66—74 Victoria Street, London, S.W.1, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement: —

This invention concerns endoprosthetic devices and more particularly such devices for replacing the articular surfaces of the elbow joint in circumstances where the function of these surfaces is seriously impaired by disease or other conditions.

Endoprosthetic elbow joint devices are already commercially available for clinical use, and normally take the form of a directly mechanically linked hinge assembly which is connected between the humerus and ulna. One example of a device of this kind is described in British Patent Specification No. 1,305,391. However, while such hinge-form devices can be used beneficially, it is now generally agreed by those versed in the art of bone joint endoprostheses that this beneficial use is an optimum only in respect of certain conditions.

In order to better meet the needs of other conditions, more recent proposals for endoprosthetic elbow joint devices have centred on the use of indirectly linked assemblies which have bearing surfaces held in mutual articulatory engagement by the natural capsule of the joint. An example of a device of this kind is described in British Patent Specification No. 1,452,924. However, as with the above hinge-form devices, those of the more recent proposals have taken account of replacement of only those surfaces engaged in the ulno-humeral articulation, and normally involve excision of the radial head.

Since an indirectly linked device will normally be used in circumstances in which the natural capsule and the main bodies of the bones of the joint are reasonably healthy, it is questionable whether the radial articulation should be removed. Accordingly, an object of the present invention is to provide a further device which avoids the need for such removal.

To this end, an endoprosthetic elbow joint device according to the invention comprises: a humeral component including first and second portions respectively defining first and second bearing surfaces by coaxial first and second surfaces of revolution, said first bearing surface having concave axial shape and convex circumferential shape, with the latter shape extending over at least a major arcuate segment, said second bearing surface having convex axial shape and convex circumferential shape, with the latter shape extending over a less arcuate segment than the corresponding shape of said first bearing surface, and said humeral component being bored in the axial direction of said surfaces of revolution; and an ulnar component defining a third bearing surface by a third surface of revolution generally complementary to said first bearing surface for mutual articulatory engagement therewith, said third bearing surface having convex axial shape and concave circumferential shape, with the axial shape having a curvature not less than said first bearing surface axial shape, and the circumferential shape extending over a lesser arcuate segment than that of said first bearing surface circumferential shape.

The various circumferential shapes are, of course, circular by virtue of derivation from surfaces of revolution, and it is preferred that the axial shapes be circular also. This facilitates manufacture to the requisite tolerances and surface finish for endoprosthetic bone joint devices. More specifically, it is preferred that the axial shapes of the first and third bearing surfaces be of slightly dissimilar curvatures, with the latter greater, so that a facility for mutual articulation transversely to their common radial planar direction is afforded while, at the same time, the respectively concave and convex nature of these shapes simulate the self-stabilising effect of the corresponding natural articular surfaces relative to such movements.

Regarding the circumferential shapes of

the first and third bearing surfaces: the former is of greater arcuate extent than the latter so that the articulatory engagement between these surfaces is maintained throughout flexion-extension movement. Also, since it is also desirable that this engagement should be extensive in terms of surface area to reduce the effects of wear in the components, it is preferred that these arcuate extents be approximately those of a circle and a semi-circle.

Given that the circumferential extent of the first bearing surface is to be approximately circular, and that the device is suited to circumstances in which the main bodies of the bones are healthy, it is considered appropriate to locate the humeral component by excavating the natural intracondylar notch in the humerus to receive the first portion of the component, with the remanent parts of the condyles being bored along their mean axis of rotation to receive a screw or equivalent member which is passed also through the axial bore of the compenent. While this mode of location may serve also to secure the first component, it is presently preferred, in addition, to employ acrylic cement or equivalent gap-filling medium in association with recessed configurations in the axial end surfaces of the component. Location of the ulnar component can then be effected by appropriate engagement of the first and third bearing surfaces, and securement of the ulnar component preferably involves cement and the provision of a short intramedullary stem extending from the component, remotely from its bearing surface, at an angle compatible with the cubital angular relationship between the shafts of the humerus and ulnar.

Turning to more specific considerations of the humeral component second portion: it has been proposed that both the axial and circumferential shapes be circular, and it is preferred that these shapes be of equal radius so that the second bearing surface is spherically shaped. However, while the first bearing surface is preferred as approximately circular in circumferential extent the corresponding extent of the second bearing surface is shorter and is preferably only of sufficient extent to take account of the normal range of articulation relative to the radius. This last point is also appropriate to the axial extent of the second bearing surface, and in practice both extents can be less than semi-circular, so that the second portion of the humeral component is an axial extension of the first portion providing a part-spherical surface which is less than hemispherical to serve as a cap or shield over the capitulum of the humerus. This reduces the necessity for removal of bone from the humerus, and allows a significant axial end surface to be exposed on the adjoining part of the first portion for securement in the excavated notch.

Regarding location and securement of this second portion: this can be effected at least in part by virtue of its connection with the first portion of the humeral component, the component being rotated circumferentially to locate the second portion appropriately, and being secured as discussed above. However, securement can additionally involve the provision of a recessed configuration in the non-bearing surface of the second portion to receive cement between the same and the capitulum.

In practice this humeral component second portion may articulate with the natural radial head, but if it is appropriate to replace the articulating surfaces of the humerus and ulnar, the same will normally be true of the radius. In the latter event the device will additionally involve a component for attachment to the radius, this component having a fourth bearing surface which can be concavely dished, suitably to a spherical shape complementary with the second bearing surface, or substantially planar. Such a component can be located and secured by suitable sectioning of the radial head and provision in the component of a short intramedullary stem for association with cement.

In order to provide a fuller understanding of the invention as discussed above, one embodiment of the same will now be described by way of example with reference to the accompanying drawings, in which:

Figures 1 to 4 illustrate the humeral component of the embodiment in end elevation, side elevation, cross-section, and longitudinal section, the sectional views being taken at I—I and II—II in Figure 2, respectively.

Figures 5 to 7 illustrate the associated ulnar component in side elevation, longitudinal section, and cross-section, the sectional views being taken at III—III and IV—IV in Figures 5 and 6, respectively, and

Figures 8 and 9 illustrate location of the embodiment relative to bones of the elbow joint.

The illustrated humeral and ulnar components are denoted generally at 10 and 30, and an associated radial component is similarly denoted in broken outline at 40 in Figures 8 and 9.

The humeral component 10 has first and second portions 11 and 12 of integral construction defining respective first and second bearing surfaces 13 and 14 by surfaces of revolution having a common axis of rotation 15. The surface 13 is generally hyperboloidal with convex circumferential shape extending completely circularly around the component, and concave axial shape of circular arcuate curvature. The surface 14 is part-spherically shaped with less than hemi-

spherical extent, and with greater circumferential than axial extent. The radius of this spherical shaping is slightly greater than the maximum radius of the circumferential shaping of surface 13, and the surfaces 13 and 14 are joined by way of a part-annular necked surface zone 16.

The first portion 11 has radially planar axial end faces 17 and 18, the former being in the form of a circular disc at the free end of portion 11, and the latter being of major circular segmental disc form adjacent the second portion 12. Each of these end surfaces is formed with a recessed configuration, the first having an annular groove 19, and the second a part-annular groove 20, with both grooves having like radius centred on the axis 15. The portion 11 is also formed with an axial bore 21 which is countersunk at both its ends.

The second portion 12 has a radially planar axial end face 22, and a longitudinal face 23 which is planar and parallel to a diametral plane of the component, but is recessed by the formation of a conical depression 24 therein.

Turning to the ulnar component 30: this comprises a bearing portion 31 from which an intramedullary stem 32 integrally extends. The bearing portion 31 is of part-annular form, with its inner surface 33 serving as a third bearing surface. The surface 33 is defined by a generally hyperboloidal surface of revolution relative to an axis 34 and is substantially complementary to the first bearing surface 13, but the circumferential shape of the surface 33 is concave and extends over a smaller arcuate range than that of the surface 13, and the axial shape of the surface 33 is circularly arcuate but of slightly greater curvature than in the surface 13. More specifically, the circumferential angular range of surface 33 is just less than a semi-circle so that this surface can be coaxially engaged with surface 13.

The stem 32 is connected with the outer surface of the bearing portion 31 at a position which is off-set both axially and circumferentially relative to respective medial radial planes of the latter, and the longitudinal axis of the stem is angled towards the nearer ones of both the axial and circumferential ends of the bearing portion.

Figures 8 and 9 illustrate the intended location of the components 10 and 30 in the humerus and ulna, the latter being respectively denoted at 50 and 60 in chain line. The component 10 is located in the humerus with its axis 15 aligned with the mean axis of rotation of the joint, and with the component rotated about these aligned axes to locate the second portion 12 in the position of the humeral capitulum which articulates with the radius, the radius being denoted at 70. In practice, attainment of this location can be effected by approaching the joint from the rear, sectioning the olecranon and flapping the same back to expose the articular surfaces of the humerus, boring the humerus along the relevant axis, excavating the intracondylar notch and suitably sectioning the capitulum, and then securing the component 10 with acrylic cement and also by passage of screws through the bone into either one end or both ends of the component bore.

The ulnar component 30 is engaged with the humeral component, and the former secured to the ulna by way of its stem 32 and with use of cement. The relevant zone of the ulna is, of course, appropriately prepared to receive the component 30, and the olecranon can be resecured by use of wiring and cement.

Lastly in Figures 8 and 9, the radial component 40 is shown as comprising a bearing portion 41 of slightly oval disc form with a short intramedullary stem 42 extending axially from one face thereof, and shallow concave dishing in its other face. This component is secured with cement, following suitable preparation of the radial head, to engage its dished face with the humeral component second bearing surface.

While the invention has been described with more particular reference to the illustrated embodiment, it will be appreciated that some variation is possible within the more general discussion preceding such description. For example, nothing has been said of materials, but these can be chosen from those of proven suitability for endoprosthetic bone joint devices. Combined use of metal, such as chrome-cobalt alloy or stainless steel, and plastics materials, such as ultra high molecular weight polyethylene, is currently favoured. In the illustrated example, such a combination can involve plastics material for the ulnar and radial components, and metal for the humeral component. An alternative arrangement can involve an ulnar component of two-part construction involving a metal base with integral stem, and a plastics bearing portion, as described in said Specification No. 1,452,924. In either event, use of a plastics ulnar component can allow the use of a snap-fit with the humeral component, if desired.

Also, it may be appropriate to provide the humeral component as a two-part construction with the first and second portions connected in axially adjustable manner. This would allow adjustment of the spacing between the first and second bearing surfaces, and can also allow interchangeability between humeral component portions of different sizes, to take account of variations in bone structures between individual patients.

WHAT WE CLAIM IS:—

1. An endoprosthetic elbow joint device comprising: a humeral component including first and second portions respectively defining first and second bearing surfaces by coaxial first and second surfaces of revolution, said first bearing surface having concave axial shape and convex circumferential shape, with the latter shape extending over at least a major arcuate segment, said second bearing surface having convex axial shape and convex circumferential shape, with the latter shape extending over a lesser arcuate segment than the corresponding shape of said first bearing surfaces, and said humeral component being bored in the axial direction of said surfaces of revolution; and an ulnar component defining a third bearing surface by a third surface of revolution generally complementary to said first bearing surface for mutual articulatory engagement therewith, said third bearing surface having convex axial shape and concave circumferential shape, with the axial shape having a curvature not less than that of said first bearing surface axial shape, and the circumferential shape extending over a lesser arcuate segment than that of said first bearing surface circumferential shape.

2. A device according to Claim 1 wherein the axial shapes of said first and second bearing surfaces are of substantially circular arcuate form.

3. A device according to Claim 1 or 2 wherein the respective circumferential extents of said first and second bearing surfaces are circular and approximately semicircular.

4. A device according to any one of Claims 1, 2 or 3 wherein the axial shape of said third bearing surface is of substantially circular arcuate form.

5. A device according to Claim 4 wherein the axial and circumferential curvatures of said second bearing surface are not greater than the maximum circumferential curvature of said first bearing surface.

6. A device according to Claim 4 or 5 wherein said second bearing surface is spherically shaped.

7. A device according to Claim 6 wherein said second bearing surface is of less than hemispherical extent.

8. A device according to any preceding claim wherein said second bearing surface is of greater circumferential extent than axial extent.

9. A device according to any preceding claim wherein said first and second bearing surfaces are mutually joined by a part-annular surface of generally necked form.

10. A device according to any preceding claim wherein said humeral component is of integral construction.

11. A device according to any of Claims 1 to 9 wherein said humeral component first and second portions are separably connected in axially adjustable manner.

12. A device according to any preceding claim wherein the axial end surface areas of said humeral component first portion are each formed with a recessed configuration.

13. A device according to Claim 12 wherein said recessed configurations comprise circular arcuate grooves.

14. A device according to Claim 12 or 13 wherein the surface area of said humeral component second portion opposite said second bearing surface is formed with a recessed configuration.

15. A device according to Claim 14 wherein the last mentioned surface area is of axially-directed planar form having a recess therein.

16. A device according to any preceding claim wherein said ulnar component comprises a bearing portion of generally part-annular form and a stem extending integrally from the outer surface of such portion in a generally radial direction.

17. A device according to Claim 16 wherein said stem joins said bearing portion in an off-set position both axially and circumferentially relative to the part-annular form of the bearing portion, said stem being inclined towards both the nearer axial and circumferential ends of said part-annular form.

18. A device according to any preceding claim further comprising a separate component for attachment to the radius and defining a fourth bearing surface for mutual articulatory engagement with said second bearing surface.

19. A device according to Claim 18 wherein said fourth bearing surface is substantially planar.

20. A device according to Claim 18 wherein said fourth bearing surface is of concavely dished shape.

21. A device according to Claims 6 and 20 wherein said fourth bearing surface is spherically shaped to be substantially complementary with said second bearing surface.

22. A device according to any one of Claims 18 to 21 wherein said separate component comprises a bearing portion of disc form of which one face defines said fourth bearing surface and from the other face of which projects a stem.

23. A device according to Claim 22 wherein said bearing portion is of generally oval disc form.

24. An endoprosthetic elbow joint device substantially as herein described with reference to the accompanying drawings.

G. PARKER,
Chartered Patent Agent,
Agent for the Applicant.

Printed for Her Majesty's Stationery Office by Burgess & Son (Abingdon), Ltd.—1978.
Published at The Patent Office, 25 Southampton Buildings, London, WC2A 1AY
from which copies may be obtained.

1528906 COMPLETE SPECIFICATION
2 SHEETS This drawing is a reproduction of the Original on a reduced scale
Sheet 1

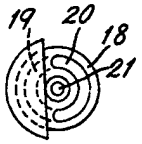

Fig. 1

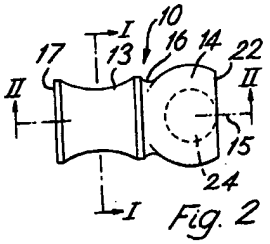

Fig. 2

Fig. 3

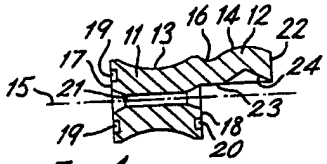

Fig. 4

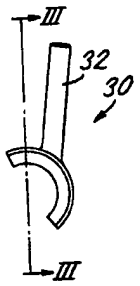

Fig 5

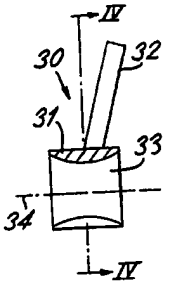

Fig. 6

Fig. 7

1528906 COMPLETE SPECIFICATION
2 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
Sheet 2

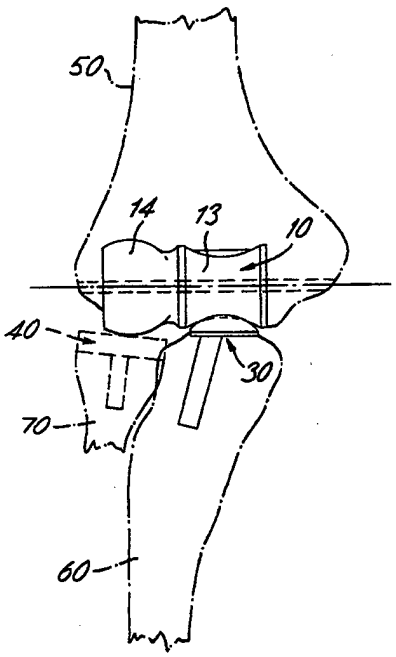

Fig. 8

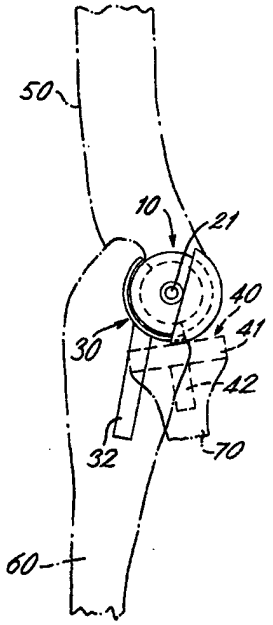

Fig. 9